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Commentary

Nanotechnology Approaches for Nano-Pesticides and Nano-Insecticides

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COMMENTARY

The twenty-first century is confronted with a huge challenge: how to feed an ever-increasing human population. By 2025, the world's population could surpass eight billion people, according to McCalla. Agriculture is directly or indirectly responsible for the majority of the world's population. Chemicals such as insecticides and fertilisers are commonly used to increase food production. In agriculture, a wide range of pesticides are utilised to address biotic stressors, yet these have significant negative consequences for crop quality and soil health. The delivery of huge volumes of fertilisers, such as ammonium salts, urea, nitrate, or phosphate compounds, causes soil quality to deteriorate. The majorities of chemical fertilisers supplied to plants are not absorbed by the plants and end up in the soil. Water pollution occurs as a result of run-off. The indiscriminate use of fertilisers, insecticides, and herbicides depletes the soil's nutrients and fertility. The agricultural industry is the lifeblood of developing nations. As a result, there is a pressing need to develop technology that will make modern agriculture more productive, cost-effective, and environmentally benign. Several environmentally friendly pest control technologies, such as biopesticides and bioinsecticides, are already in use to control pests through non-toxic mechanisms. Nanotechnology creates materials on the nanoscale scale, with sizes ranging from 1 to 100 nanometers.

DESCRIPTION

The ratio of surface area to volume in nanomaterials is raised due to their small size, enhancing biochemical reactivity and giving uncommon and desirable physical features. It is a rapidly developing branch of study with numerous applications in both basic and applied sciences. Nanotechnology is increasingly being used in agriculture to improve food quality, reduce agricultural inputs, improve nutrient content, and extend shelf life. To limit the usage of hazardous chemicals, many nano-agricultural products are now being created. Many issues of food security, medical treatment, and new tools are all covered by nanotechnology. Pathogen identification, effective delivery mechanisms, and packing materials are all important considerations. Nanotechnology has been used to generate a variety of nanomaterials such as nanopesticides, nanoinsecticides, nanoemulsion, and nanoparticles. Metal oxides, plant extracts, ceramics, silicates, lipids, polymers, and emulsions are among the materials utilised to produce and cover nanomaterials. Due to increased surface tension than typical surfaces, surface coated nanomaterials or nano-coated fertiliser particles cling the substance to the plant more firmly [1].

Nano coatings also shield bigger particles from the elements. A nanocapsule is made out of a shell that houses an active ingredient, such as a chemical or biological agent, that protects plants from pests and illnesses. Lipids, polymers, viral capsids, and nanoclays are among the components of the shell. Pesticides are chemicals that are used to keep pests and pathogens at bay. Herbicides, insecticides, nematicides, molluscicides, rodenticides, bactericides, antimicrobials, and fungicides are examples of pesticides used to control biotic stress agents. Disinfectants, sanitizers, and repellants are also included. Pathogens, pests, weeds, and herbivores are all controlled by these compounds. Pesticides can have both immediate and delayed negative health consequences in people [2].

Animals' skin and eyes might become irritated as a result of pesticide exposure. It can also harm the neurological system, mimic hormones, and cause reproductive issues, as well as cancer. The usage of pesticides raises a number of environmental issues. Approximately 95% of herbicides and 98 percent of insecticides are sprayed on crops that end up in places other than their intended targets, such as non-target species, air, water, and soil. Thus resulting in biodiversity loss, water pollution, air pollution, and soil degradation. Pesticide resistance develops as a result of overuse, necessitating the development of new pesticides that are more powerful, toxic, and dangerous not only to the pest but also to humans and the environment [3]. Nanotechnology has the ability to minimize the amount of active substances used in agricultural production, saving the environment and lowering costs. To improve the insecticidal evaluation, "nano-encapsulation" can be utilised. The active pesticide ingredient is encased by a thin-walled sac in the nano-encapsulation process. In this case, the successful strategy is "controlled release of the active ingredient," which would

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considerably boost efficiency while reducing pesticide input and associated environmental risks. Food is a basic need for the rapidly rising human population, and the resulting global demand for food has prompted agricultural crops to be better protected from pest infestation [4].

Nano-insecticides have a number of advantages over bulk insecticides, including increased efficiency of natural and chemical insecticides due to controlled release, less environmental contamination due to reduced rate of application, easy and safe handling, greater susceptibility to photo degradation, and lower toxicity to non-target organisms. The majority of pesticides have been encapsulated using polymer-based nano formulations. For the manufacture of nano-insecticides, several polysaccharides such as chitosan, alginates, starch, and polyesters have been investigated. Insecticides have been encapsulated using a variety of polymer and non-polymer based nanoformulations such as nanoparticles, nanofibres, nanogels, nanospheres, micelles, nanoemulsions, and nanocapsules. Nanocapsules are by far the most used method for controlling the release of pesticides. Many natural pesticides have been nanoformulated [5]. The sophisticated use of biodegradable and biocompatible polymers of natural origin over synthetic ones for encapsulation is being driven by a growing concern of environmental damage.

Conflict of Interest

None

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